

1 CLAIMS:

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3 1. An optical system for presenting virtual optical images of an image source
4 outputting light in a forward direction at a desired apparent distance comprising:
5 (a) a first at least partially light transmissive member having a non-uniform
6 transmission characteristic for receiving light from said image source and outputting
7 altered light in a forward direction;
8 (b) a partially transparent and partially reflective focusing member receiving said
9 altered light and outputting transmitted altered light; and
10 (c) a partially transmissive and partially reflective member for reflecting said
11 transmitted altered light in a rearward direction toward said focusing member, said
12 focusing member having the characteristic of reflecting said reflected transmitted
13 altered light, and said partially transmissive and partially reflective member
14 transmitting reflected transmitted altered light reflected from said partially
15 transparent and partially reflective focusing member.

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17 2. An optical system as in claim 1, wherein said first at least partially light
18 transmissive member having a non-uniform transmission characteristic for receiving
19 light from said image source and outputting altered light comprises a first polarizer.

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21 3. An optical system as in claim 2, wherein said first polarizer comprises a circular
22 polarizer comprising a linear polarizer and quarter wave plate.

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24 4. An optical system as in claim 3, wherein said partially transparent and partially
25 reflective focusing member receiving said altered light and outputting transmitted
26 altered light comprises a partially transmissive concave mirror.

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28 5. An optical system as in claim 4, wherein said partially transmissive and partially

1 reflective member for reflecting said transmitted altered light in a rearward direction
2 toward said focusing member comprises a quarter wave plate and a
3 reflective/transmissive polarizer.

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5 6. An optical system as in claim 1, wherein said partially transmissive and partially
6 reflective member for reflecting said transmitted altered light in a rearward direction
7 toward said focusing member comprises a quarter wave plate and a
8 reflective/transmissive polarizer.

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10 7. An optical system for presenting virtual optical images of an image source
11 outputting light in a forward direction at a desired apparent distance comprising:
12 (a) a first linear polarizing element oriented to receive light from said image source
13 and output first linearly polarized light having an orientation in a first direction,
14 said first linear polarizing element being oriented in said first direction;
15 (b) a first elliptical polarizing member oriented in a second direction and positioned
16 to receive said first linearly polarized light and output first elliptically polarized
17 light, said first elliptically polarized light being oriented in a first elliptical direction;
18 (c) a partially transparent and partially reflective focusing member positioned to
19 receive said first elliptically polarized light and transmit a portion of said first
20 elliptically polarized light;
21 (d) a second elliptical polarizing member positioned to receive said portion of said
22 first elliptically polarized light from said focusing member and transmit said portion
23 of said first elliptically polarized light as second linearly polarized light, said second
24 linearly polarized light being oriented in said first direction; and
25 (e) a reflective-transmissive polarizer configured and positioned to reflect light
26 having a linear polarization in said first direction and transmit light having a linear
27 polarization in a direction transverse to said first direction, said second elliptical
28 polarizing member being configured and positioned to convert linearly polarized

1 light reflected in a rearward direction by said reflective-transmissive polarizer into
2 second elliptically polarized light with said second elliptically polarized light being
3 polarized in said first elliptical direction, said concave mirror being positioned to
4 reflect in a forward direction said second elliptically polarized light as third
5 elliptically polarized light, said third elliptically polarized light having a second
6 elliptical direction different from said first elliptical direction, and said second
7 elliptical polarizing member being positioned to convert said third elliptically
8 polarized light into third linearly polarized light, transmitting said third linearly
9 polarized light in a forward direction, said third linearly polarized light being
10 oriented in a second direction transverse to said first direction, whereby said
11 reflective-transmissive polarizer transmits said third linearly polarized light in a
12 forward direction.

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14 8. An optical system as in claim 7, further comprising:

15 (f) a second linear polarizing element oriented to receive light from said reflective-
16 transmissive polarizer, said second linear polarizing element being configured and
17 positioned to transmit light having a linear polarization in said second direction.

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19 9. An optical system as in claim 7, wherein said elliptical polarizing members are
20 circular polarizing members.

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22 10. An optical system as in claim 9, wherein said circular polarizing members are
23 quarter wave plates.

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25 11. An optical system as in claim 7, wherein said elliptical polarizing members are
26 manufactured using a coating process.

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28 12. An optical system as in claim 7, wherein said reflective-transmissive polarizer is

1 formed of a liquid crystal material.

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3 13. An optical system as in claim 7, wherein said elliptical polarizing members are
4 coated onto opposite sides of said partially transparent and partially reflective
5 concave mirror.

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7 14. An optical system as in claim 7, wherein said elliptical polarizing members are
8 circular polarizing members and said circular polarizing members are quarter wave
9 plates.

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11 15. An optical system as in claim 7, wherein said reflective-transmissive polarizer
12 comprises a wire grid.

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14 16. An optical system as in claim 7, wherein said first and second elliptical
15 polarizing members are one quarter wave retarders comprising liquid crystal
16 materials configured to incorporate characteristics tailored to correct darkened
17 corner phenomenon.

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19 17. An optical system as in claim 7, wherein said first and second elliptical
20 polarizing members are configured to incorporate characteristics tailored to correct
21 darkened corner phenomenon.

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23 18. An optical system as in claim 7, further comprising an image source comprising
24 a polarized projector and a screen fabricated with liquid crystal materials that
25 largely maintain the linear polarization of said projector.

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27 19. An optical system as in claim 7, wherein said reflective-transmissive polarizer
28 comprises a liquid crystal member.

1 20. An optical collimating apparatus for focussing an image at or closer than at an
2 infinite distance from an observer, comprising:

- 3 (a) a first elliptical polarizing filter;
4 (b) a semi-reflective concave mirror; and
5 (c) a reflective-transmissive polarizing member.

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7 21. An optical collimating apparatus as in Claim 20, further comprising:
8 (d) a second elliptical polarizing filter.

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10 22. An optical collimating apparatus as in Claim 21, wherein said first and second
11 elliptical polarizing filters are positioned on opposite sides of said semi-reflective
12 concave mirror.

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14 23. An optical collimating apparatus as in Claim 22, wherein said reflective-
15 transmissive polarizing member is panchromatic.

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17 24. An optical collimating apparatus as in Claim 23, wherein said reflective-
18 transmissive polarizing member receives linearly polarized light and outputs
19 linearly polarized light.

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21 25. An optical collimating apparatus as in Claim 20, wherein said reflective-
22 transmissive polarizing member receives linearly polarized light and outputs
23 linearly polarized light.

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25 26. An optical collimating apparatus as in Claim 25, wherein said first and second
26 elliptical polarizing filters are positioned on opposite sides of said semi-reflective
27 concave mirror.

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1 27. Image-forming apparatus comprising a first linear polarizer, a first quarter-wave
2 plate adjacent said first polarizer and having its fast and slow axes at substantially
3 45° to the plane of polarization of said first polarizer, a beam-splitting curved mirror
4 having a convex surface adjacent the first polarizer and facing towards the first
5 quarter-wave plate, a second quarter-wave plate adjacent the concave side of the
6 curved mirror, said second quarter-wave plate having its fast and slow axes oriented
7 with respect to the corresponding axes of the first quarter-wave plate at angles
8 substantially equal to a first integral multiple of 90°, and a reflective-transmissive
9 polarizing member adjacent said second quarter-wave plate.

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11 28. Image-forming apparatus as in Claim 27, further comprising a second linear
12 polarizer adjacent said reflective-transmissive polarizing member, the second linear
13 polarizer having its plane of polarization oriented with respect to the plane of
14 polarization of the first linear polarizer at an angle substantially equal to a second
15 integral multiple of 90°, both of said multiples being even or both being odd.

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17 29. An optical collimating apparatus as in Claim 28, wherein said reflective-
18 transmissive polarizing member receives linearly polarized light and outputs
19 linearly polarized light.

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21 30. Image-forming apparatus for forming an image appearing as if at a distance,
22 comprising a first linear polarizer, a first quarter-wave plate, a beam-splitting
23 curved mirror having a convex surface adjacent the first polarizer, a second quarter-
24 wave plate adjacent the concave side of the curved mirror, said second quarter-wave
25 plate, and a pseudo-depolarizing member positioned to filter the output of the

1 imaging forming apparatus.

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3 31. Image-forming apparatus as in Claim 30, wherein said first quarter-wave plate
4 has its fast and slow axes at substantially 45° to the plane of polarization of said first
5 polarizer, said beam-splitting curved mirror faces towards the first quarter-wave
6 plate, and said second quarter-wave plate has its fast and slow axes oriented with
7 respect to the corresponding axes of the first quarter-wave plate at angles
8 substantially equal to a first integral multiple of 90°.

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10 32. Image-forming apparatus as in Claim 30, further comprising a reflective-
11 transmissive polarizing member adjacent said second quarter-wave plate.